Supplementary Report on Experiments in Periarterial Sympathectomy.

By

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Introduction.

Since René Leriche emphasised the use and effect of Periarterial Sympathectomy on the arteria femoralis as a surgical remedy for certain troubles of the lower limbs, a large number of scientists all over the world have eagerly taken the matter up as an object of investigation and criticism.

The operation is to be traced back to Jaboulay who in 1899 defined it as "Le traitement de quelques troubles trophiques du pied et de la jambe par la dénudation de l'artere fémorale et la déstruction des nerfs vasculaires" and explained its operation technique to consist in "isoler l'artére comme pour une ligature sur toute sa péripherie et à arracher les nerfs vasculaires qui passent sur elle à ce niveau." The suggestion was first worked out chiefly by R. Leriche whose suit has since been followed by many investigators.

According to Leriche and Brüning, in clinically effecting this operation Periarterial Sympathectomy should be made on the arteria femoralis to the extent of from 8 to 12 c.m.s beginning at a point slightly away from the lig. Pouparti (three fingers placed sideways below it, according to Brüning), inasmuch as an operation effected above or

below the said point will not have the effect of periarterial denudation, because the sympathetic nerve fibres are scarce above it, while below it the artery is considerably ramified and the nerves take a collateral course. In other words, it is insisted that in order to find in the operation field a place where the sympathetic nerve fibres exist along the vessel wall, it is positively necessary that the distance of the denudation should be at least 8 c.m.s.

Having tried experimental periarterial sympathectomy on dogs after Leriche's method, I ascertained that the operation was followed by active hyperaemia even though it was of short duration (as stated in my first report on Periarterial Sympathectomy) and that the longer the denudation, the more durable was its effect (as detailed in my second report).

In the present report, it is my intention to go one step farther towards the elucidation of the real nature of Periarterial Sympathectomy by describing the results of further experiments made for clearing up the following two points, namely:

(1) Why did Leriche in his periarterial sympathectomy extend the distance of the denudation from 2 c.m.s to from 8 to 10 c.m.s?

In other words, how and why is the result of the operation affected by a variation in the length of the denudation?

(2) Is it that periarterial sympathectomy effected directly above or below the lig. Pouparti or at the distal of the arteria femoralis is devoid of any effect, as contended by Leriche and Brüning?

Experiments.

Experiments in the present instance were likewise made on dogs exactly in the same manner as that described in my report I and II on Experimental Sympathectomy.

It will be remembered that by my previous experiments the following two facts were demonstrated, namely,

(1) that in the case of a healthy dog under normal conditions the maximum difference in blood-flow between the right and left hind legs does not exceed 0.500 c.c. per minute and (2) that during a certain time after periarterial sympathectomy the blood-flow on the operated side decrease, but that for a period of from 4 hours and 30 minutes to 6 hours and 20 minutes there is always an increase in blood-flow. In those of the experiments under report the result of which I wanted to ascertain on the very day they were made, I began by measuring the blood-flow in the right and left hind legs in normal condition, and after effecting periarterial sympathectomy, I observed the blood-flow on both sides for a fixed time, always after the lapse of at least 3 hours and 30 minutes from the operation.

Record of Experiments.

In order to clear up the first point referred to in the introduction, I started my periarterial sympathectomic operations always at a point 1 c.m. from the lig. Pouparti.

1/X 25. EXP. **I.** Periarterial Sympathectomy.

No. 1 dog ♂ Black Wt. 10.200 Kgm.

(2 cms. denudat. on the left side at P. M. 6.30.)

Before Periart. Sympathectomy.

Hrs. P.M.	Mins.	Blood-flow per min. c.c. R.	L.	Diff.	Past hours af. op. Hrs.	Mins.
5	50	3.000.	2.786.	0.214. (R. +)	Balance. 0.066. (R. +)	
6	00	2.352.	2.500.	0.148. (L. +)		
		After Periart. Sympathectomy.				
10	10	2.272.	2.307.	0.035. (L. +)	3	40
10	30	2.238.	2.308.	0.070. (L. +)	4	00
10	50	2.083.	2.702.	**0.619.** (L. +)	4	20
11	00	2.068.	2.702.	**0.634.** (L. +)	4	30

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5/X. EXP. **II.** Periarterial Sympathectomy.

No. 2 dog ♂ Brown Wt. 6.600 Kgm.

(3 cms. denudat. on the left side at P.M. 12.30.)

Before Periart. Sympathectomy.

Hrs. A.M.	Mins.	Blood-flow per min. c.c. R.	L.	Diff.	Past hours af. op. Hrs.	Mins.
11	20	2.075.	2.068.	0.007. (R. +)		
		After Periart. Sympathectomy.				
P.M.						
5	00	1.754.	2.352.	**0.598.** (L. +)	3	40
5	10	1.282.	2.112.	**0.830.** (L. +)	4	40
5	40	1.666.	2.189.	0.523. (L. +)	5	10
5	50	1.271.	2.054.	0.773. (L. +)	5	20
6	00	1.470.	2.205.	0.735. (L. +)	5	30

6	10	1.470.	2.255.	0.785. (L. +)	5	40
6	20	1.666.	2.222.	0.556. (L. +)	5	50
6	30	1.512.	1.840.	0.328. (L. +)	6	00

6/X. EXP. **III. A.** Periarterial Sympathectomy.

No. 3 a dog ♀ Brown Wt. 8.400 Kgm.

(**4** cms. denudat. on the **left** side at A.M. 11.)

Before Periart. Sympathectomy.

Hrs.	Mins.	B.H. (R.T.)	Blood-flow per min. c.c. R.	**L.**	Diff.	Past hours af. op. Hrs.	Mins.
A.M. 10	00	37.2 c	3.658.	3.614.	0.044. (R. +)		

After Periart. Sympathectomy.

P.M. 0	40	do	3.750.	3.157.	0.593. (R. +)	1	40
1	00	do	3.447.	3.333.	0.114. (R. +)	2	00
1	20	do	3.750.	3.409.	0.341. (R. +)	2	20
1	40	do	3.658.	2.941.	0.717. (R. +)	2	40
2	00	do	3.703.	2.970.	0.733. (R. +)	3	00
2	30	do	3.658.	2.857.	0.801. (R. +)	3	30
3	00	37. c	3.125.	2.912.	0.213. (R. +)	4	00
3	20	do	3.333.	3.529.	0.196. (L. +)	4	20
3	40	do	2.586.	3.092.	**0.506.** (L. +)	4	40
3	50	do	2.479.	2.857.	0.378. (L. +)	5	00

8/X. EXP **III. B.** Periaterial Sympathectomy.

No. 3 b dog ♀ Black Wt. 9.200 Kgm.

(**4** cm. denudat. on the **left** side at P.M. 2.30)

Before Periart. Sympathectomy.

Hrs.	Mins.	Blood-flow per min. c.c. R.	**L.**	Diff.	Past hours af. op. Hrs.	Mins.
P.M. 1	30	3.409.	3.448.	0.039. (L. +)		

After Periart. Sympathectomy.

A.M. 6	30	3.333.	3.333.	0.	4	00
7	00	3.157.	3.529.	**0.372.** (L. +)	4	30
7	10	3.092.	3.333.	0.241. (L. +)	4	40
7	20	2.926.	3.191.	0.265. (L. +)	4	50
7	30	2.752.	3.076.	0.324. (L. +)	5	00
7	40	2.803.	2.884.	0.081. (L. +)	5	10
7	50	2.542.	2.666.	0.124. (L. +)	5	20
8	00	2.479.	2.608.	0.129. (L. +)	5	30

8/X. EXP. **IV.** Periarterial Sympathectomy.

No. 4 dog ♀ Black Wt. 10.600 Kgm.

(**5** cms. denudat. on the **left** side at P.M. 11.50.)

Before Periart. Sympathectomy.

Hrs.	Mins.	B.H. (R. T.)	Blood-flow per min. c.c. R.	**L.**	Diff.	Past hours af. op. Hrs.	Mins.
A.M. 10	30		3.000.	2.441.	0.059. (R. +)		

After Periart. Sympathectomy.

P.M. 3	20	37. c	3.529.	3.333.	0.196. (R. +)	3	30
4	00	do	2.941.	2.803.	0.134. (R. +)	4	10
4	10	do	2.702.	3.000.	**0.298.** (L. +)	4	20
4	20	do	2.678.	3.157.	**0.479.** (L. +)	4	30
4	30	do	2.857.	3.000.	0.143. (L. +)	4	40
4	40	do	2.631.	2.857.	0.226. (L. +)	4	50
4	50	do	2.631.	2.727.	0.096. (L. +)	5	00
5	00	do	2.608.	2.857.	0.249. (L. +)	5	10
5	10	do	2.542.	2.970.	0.428. (L. +)	5	20
5	20	do	2.439.	2.521.	0.082. (L. +)	5	30

In Experiment I, where the denudation was 2 c.m.s long, the greatest difference between the right and left sides was 0.685 c.c. in favour of the operated side observed 4 hours and 20 minutes after the operation (but under normal conditions beeing 0.066 c.c. in favour of the right side, that difference (0.066 c.c.) was added to the difference after the operation (0.685 c.c.) in order to real difference. In the case of the other experiments the same allowance for the difference in normal conditions was made for the same reason).

Four hours and thirty minutes after the operation the difference was 0·700 c.c., so that there was an average increase of 0.692 c.c.

In Experiment II, the denudation was extended to 3 c.m.s, with the result that the increase in blood-flow on the operated side was 0.605 c.c. 4 hours and 30 minutes after the operation and 0.837 c.c. 4 hours and 40 minutes after the operation, the increase thus averaging 0.721 c.c.

In Experiment III, in which the denudation was effected to the extent of 4 c.m.s, the operated side showed an increase of 0.395 c.c. 4 hours and 20 minutes and 0.550 c.c. 4 hours and 40 minutes after the operation, that is, 0.395 c.c. on an average in the case of Experiment III (A), an increase of 0.533 c.c. 4 hours and 30 minutes and 0.202 c.c. 4 hours and 40 minutes after the operation, that is, 0.267 c.c. on an average in the case of Experiment III (B).

In Experiment IV, where the length of the denudation was 5 c.m.s there was observed on the operated side an increase of 0.357 c.c. 4 hours and 20 minutes and 0.538 c.c. 4 hours and 30 minutes after the operation, or an average of 0.447 c.c..

In comparing the varied increases in blood-flow after the operation in these several instances, care was taken that observation be made at times which do not differ much after the operation for the reason that a variation in the lapse of time after the operation is followed by a considerable difference in blood-flow for various causes.

On surveying the results of the foregoing five experiments, it is found that in Experiment III and IV, where the

denudation was of a length of 4 or 5 c.m.s, the operated side showed an increase in blood-flow, but the difference between the operated and the other side did not exceed the physiological difference (0.500 c.c.) (vide my report I), so that, for the present purpose, Experiments I and II are the only cases which it is necessary to consider.

In comparing these two cases accordingly, it is observed that the increase in blood-flow was slightly larger where the length of the denudation was 3 c.m.s than where it was only 2 c.m.s. In the case of Experiment II the increase in blood-flow, even during the interval between 5 hours and 10 minutes and 5 hours and 50 minutes after the operation, was 0.600 c.c. or over on an average, as shown in the foregoing table, whereas the increase was smaller when the denudation was extended to 4 c.m.s and 5 c.m.s as in the case of Experiments III and IV. How is this to be accounted for? According to Leriche and Brüning, the longer the denudation the better is the effect, but my experiments showed the reverse to be the case. In order to solve this difficulty, I made the following experiments.

16/X. EXP. **V.** Periarterial Sympathectomy.

No. 5 dog ♂ Brown Wt. 10.600 Kgm.

(3 cms. on the **right**; **5** cms. on the **left** side denudat.)

After Periart. Sympathectomy.

Hrs. P.M.	Mins.	Blood-flow per min. c.c. R.	L.	Diff.	Past hours af. op. Hrs.	Mins.
0	25	4.285.	3.846.	**0.439.** (R. +)	43	25
0	30	3.370.	3.296.	0.084. (R. +)	43	30
0	40	3.333.	3.157.	0.176. (R. +)	43	40
0	50	2.686.	2.686.	0.	43	50
1	00	2.544.	2.400.	0.144. (R. +)	44	00
1	05	2.526.	2.016.	**0.510.** (R. +)	44	05

Notice: "Past hours af. op." was calculated from the time when the denudation of the left side was completed.

24/X. EXP. **VI.** Periarterial Sympathectomy.

No. 6 dog ♂ Brown Wt. 8.600 Kgm.

(**3** cms. on the **left**; **6 cms.** on the **right** side denudat.)

After Periarterial Sympathectomy.

Hrs. P.M.	Mins.	B. H. (R.T.)	Blood-flow per min. c.c. R.	L.	Diff.	Past hours af. op. Hrs.	Mins.
2	20	37. c (19)	1.840.	1.666.	0.174. (R. +)	41	50
2	35	36.5 c (19)	1.666.	1.538.	0.128. (R. +)	42	05
2	40	do	1.764.	1.518.	**0.246.** (R. +)	42	10
2	45	do	1.714.	1.538.	0.176. (R. +)	42	15
2	50	do	1.643.	1.500.	0.143. (R. +)	42	20
2	55	do	1.518.	1.558.	0.040. (R. +)	42	25
3	00	36. c (19)	1.481.	1.333.	0.148. (R. +)	42	30
3	05	do	1.411.	1.276.	0.035. (R. +)	42	35

Notice: Past hours af. op." was calculated from the time when the denudation of the right side was completed.

Under ordinary circumstances the increase in blood-flow was observed to be considerable from 16 hours to 4 days after the denudation (vide my report I), but in the above two particular instances even though the denudation was made from 2 c.m.s to 3 c.m.s longer there was no remarkable difference in blood-flow. the difference noted beeing within the limits of the physiological difference. But as I did not ascertain the physiological difference in blood-flow before the operation in the above two cases, and also as it was believed that the slight difference between both instances that was observed in the above cases was inadequate to warrant a reliable conclusion concerning the effects of denudation of various lengths, I further made the following experiment.

29/X. EXP. **VII.** Periarterial Sympathectomy.

No. 7 dog ♀ Brown Wt. 9.600 Kgm.

(**3** cms. on the **right** at A. M. 11 ; next **7** cms. on the **left** side at P. M. 0.30 denudat.)

Before Periart. Sympathectomy.

Hrs.	Mins.	B.H. (R.T.)	Blood flow per min. c.c. R.	L.	Diff.	Past hours af. op. Hrs	Mins.
A.M. 10	00		2.325.	2.307.	0.018. (R. +)		

After Periart. Sympathectomy.

P.M. 4	00	38. c (16 5)	1.408.	1.379.	0.029. (R. +)	3	30
4	30	do	1.369.	1.234.	**0.135.** (R. +)	4	00
4	40	do	1.224.	1.090.	**0.134.** (R. +)	4	10
4	50	37. c (16.5)	1.102.	1.000.	0.102. (R. +)	4	20
5	00	37. c (16.)	1.034.	0.952.	0.082. (R. +)	4	30
5	10	do	0.984.	0.960.	0.024. (R. +)	4	40
5	20	do	0.895.	0.869.	0.026. (R. +)	4	50
5	30	36.5. c (16.)	0.833.	1.000. (crying)	0.167. (L. +)	5	00
5	40	do	0.857.	0.820.	0.037. (R. +)	5	10
5	50	do	0.923.	0.857.	0.066. (R. +)	5	20
6	00	36. c (16.)	0.812.	0.821.	0.009. (L. +)	5	30
6	10	do	0.759.	0.789.	0.030. (L. +)	5	40
6	20	do	0.774.	0.764.	0.010. (R. +)	5	50
6	30	do	0.774.	0.786.	0.012. (L. +)	6	00
6	50	do	0.794.	0.800.	0.006. (L. +)	6	20
7	00	do	0.761.	0.706.	0.055. (R. +)	6	30
7	20	do	0.670.	0.677.	0.007. (R. +)	6	50
7	25	do	0.631.	0.625.	0.006. (R. +)	6	55

Notice : "Past hours af. op." was calculated from the time when the denudation of the left side was completed.

In this particular instance it was distinclty observed that the increase in blood-flow on the side when denudation

was made to the extent of 3 c.m.s was greater than on the other side where the denudation was of a length of 7 c.m.s.

In my report II on Experimental Periarterial Sympathectomy (p. 138) I described how denudation was effected 2 c.m.s long on one side and 7 c.m.s on the other, and how on examining the blood-flow twenty-one days after the operation the difference between the two sides was observed to be about 2 c.c.s. In this instance, however, the denudation was not started at a fixed point, all the restriction on its location beeing that it was effected in Scarpa's triangle.

It proved nothing but that in that particular instance a longer denudation showed a better result.

From the experiments so far described it would appear that a 3 c.m. denudation produces a better result than in any other instance, but the experiments were open to the objections that the time of observation was short and that the figures showing the difference in blood-flow between the right and left sides was comparatively small. So denudation was next made at the various lengths of 3 c.m.s, 5 c.m.s and 7 c.m.s and the blood-flow was examined similarly three days after the operation.

13/XI. EXP. **VIII.** Periarterial Sympathectomy (3 days after operation).

No. 8 dog ♀ White Wt. 8.500 Kgm.

(**3** cms. denudat. on the **right** side on the 10th.)

Hrs.	Mins.	B.H. (R.T.)	Blood-flow per min. c.c. R.	L.	Diff.
A.M. 11	30	38. c (18.)	5.714.	3.703.	2.011. (R. +)
11	35		5.882.	3.750.	2.132.
11	40		5.882.	3.703.	2.179.
11	45		5.660.	3.428.	2.232.
11	50		5.769.	3.571.	2.198.
11	55		5.818.	3.529.	2.289.
12	00		5.217.	3.409.	1.808.
P.M. 0	05		5.818.	3.240.	**2.578.**

14/XI. EXP. **IX.** Periarterial Sympathectomy (3 days after operation).

No. 9 dog ♀ Black Wt. 11.000 Kgm.

(**5** cms. denudat. on the **right** side on the 11th.)

Hrs. P.M.	Mins.	B.H. (R.T.)	Blood-flow per min. c.c. R.	L.	Diff.
0	20	39. c	6.666.	5.263.	1.403. (R. +)
0	30		6.521.	5.000.	1.521.
0	40		6.122	4.687.	1.435.
0	50	38. c (20)	6.382.	4.615.	1.767.
1	00		6.250.	4.838.	1.412.
1	10		6.666.	4.761.	1.905.
1	20		6.315.	4.687.	1.628.
1	30	38. c	6.315.	4.918.	1.397.
1	40		6.000.	4.615.	1.385.
1	50		6.315.	4.761.	1.554.
2	00	38. c	6.521.	4.687.	1.734.

14/XI. EXP. **X.** Periarterial Symeathectomy (3 days after operation).

No. 10 dog ♂ Reddish brown Wt. 9.850 Kgm.

(**7** cms. denudat. on the **right** side on the 11th.)

Hrs. P.M.	Mins.	B.H. (R.T.)	Blood-flow per min. c.c. R.	L.	Diff.
0	45		6.521.	5.357.	1.164. (R. +)
0	55	37. c (20)	6.000.	5.000.	1.000.
1	05		6.250.	4.560.	**1.690.**
1	15		5.660.	4.687.	0.973.
1	25		5.882.	4.687.	1.195.
1	35	37. c (20)	5.660.	4.615.	1.045.
1	45		6.000.	4.444.	1.556.
1	55		6.315.	4.800.	1.515.
2	05		6.315.	5.178.	1.137.
2	15		6.000.	4.615.	1.305.

In the above three experiments, the maximum difference between the right and left was 2.578 c.c.s where the denudation was 3 c.m.s long (Experiment VIII), 1.905 c.c.s where it was 5 c.m.s (Experiment IX) and 1.690 c.c.s where it was 7 c.m.s (Experiment X). While the various results of the several denudations did not show a very great difference, they were sufficient to show that the increase in blood-flow was distinctly greater when the denudation was of a 3 c.m.s (Experiment VIII) than in the case of Experiment IX and X where it was of greater lengths. In short, as a result of Experiments V and VI I was able ascertain that, so far as dogs are concerned, there was no great difference in the effect of a denudation upon the blood-flow under its control whether the length of the denudation was 3 c.m.s or greater (5 c.m.s or 6 c.m.s), while by Experiments VII, VIII, IX and X it was ascertained that the greatest result was obtained by a denudation of a length of 3 c.m.s.

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The next question is, what is the effect of denudation immediately below the lig. Pouparti? In the foregoing experiments (I—X), denudation was always started at a point 1 c.m. and upward below the lig. Pouparti, the space of 1 c.m. immediately below the said ligamentum was left intract. Periarterial Sympathectomy was now effected in this reserved part.

13/X. EXP. **XI.** Periarterial Sympathectomy.

No 11 dog ♀ Brown Wt. 5.150 Kgm.

(1 cm. denudat. on the left side at A.M. 10.30.)

Before Periart. Sympathectomy.

Blood-flow per min. c.c.

Hrs.	Mins.	R.	L.	Diff.	Hrs.	Mins.
A.M.						
10	00	2.290.	2.307.	0.017. (L. +)		
		After Periart. Sympathectomy.				
P.M.						
2	40	1.714.	1.786.	0.072. (L. +)	4	10
2	50	1.734.	1.792.	0.058. (L. +)	4	20
3	00	1.612.	1.690.	0.078. (L. +)	4	30
3	10	1.604.	1.724.	0.120. (L. +)	4	40
3	20	1.570.	1.685.	0.115. (L. +)	4	50
3	30	1.546.	1.630.	0.090. (L. +)	5	00
3	40	1.570.	1.621.	0.051. (L. +)	5	10
3	50	1.546.	1.666.	0.120. (L. +)	5	20
4	00	1.500.	1.570.	0.070. (L. +)	5	30
4	50	1.470.	1.764.	0.294. (L. +)	6	20
5	00	1.463.	1.764.	**0.301.** (L. +)	6	30

As shown in the above graph, there was even in normal conditions a difference of 0.017 c.c. in favour of the operated side.

Observation made from 4 hours and 10 minutes to 6 hours and 30 minutes after tho operation showed that the greatest differences between the two sides were 0.277 c.c.s at 6 hours and 20 minutes and 0.284 c.c.s at 6 hours and 30 minutes after the operation. In fact, there was a slight increase in blood-flow, but the increase was within the limit of the physiological difference. Denudation of 2 c.m.s in length was next made in the **arteria iliaca externa,** that is, immediately above the lig. Pouparti with the following result:

20/X. EXP. **XII.** Periarterial Sympathectomy (Art. iliaca externa).

No. 12 dog ♀ White Wt. 8.600 kgm.

(2 cms. denudat. on the left side at A.M. 11.)

Before Periart. Sympathectomy.

Hrs. A.M.	Mins.	B.H. (R.T.)	Blood flow per min. c.c. R.	L.	Diff.	Past hours af. op. Hrs.	Mins.
10	30	—	3.750.	3.750.	0.		

After Periart. Sympathectomy.

P.M.							
3	00	32.5(20)	1.846.	1.986.	0.140. (L. +)	4	00
3	10	do	1.846.	1.886.	0.040. (L. +)	4	10
3	20	do	1.578.	1.764.	**0.186.** (L. +)	4	20
3	30	do	1.621.	0.171.	0.093. (L. +)	4	30
3	40	do	1.604.	1.690.	0.086. (L. +)	4	40
3	50	do	1.693.	1.775.	0.082. (L. +)	4	50
4	00	30. c	1.587.	1.690.	0.103. (L. +)	5	00
4	10	do	1.518.	1.666.	0.148. (L. +)	5	10

It will be seen from the above that no difference was observable under normal conditions, but that observation from 4 hours and 10 minutes after the operation showed a distinct increase was only to a small extent, the largest differences beeing within the limit of the physiological difference, beeing 0.186 c.c. at 4 hours and 20 minutes and 0.148 c.c. at 5 hours and 10 minutes after the operation.

Periarterial Sympathectomy next was tried at the distal of the art. femoralis, that is, with the fork between the vena femoralis and vena saphena magna for the starting point, two denudations were effected at the proximal of the art. femoralis one of a length of 1 c.m. and the other of 2 c.m.s with the following result:

15/X. EXP. **XIII.** Periarterial Sympathectomy (distal).

No. 13 dog ♂ Black Wt. 5.700 Kgm.

(1 cm. denudat. on the left side at A.M. 10. 40.)

Before Periart. Sympathectomy.

Hrs. A.M.	Mins.	B.H. (R.T.)	Blood-flow per min. c.c. R.	L.	Diff.	Past hours af. op. Hrs.	Mins.
10	00	—	1.263.	1.276.	0.013. (L. +)		

After Periart. Sympathectomy.

P.M.							
2	40	30. c	1.600.	1.666.	0.066. (L. +)	4	00
2	50	do	1.548.	1.600.	0.052. (L. +)	4	10
3	00	do	1.411.	1.518.	**0.107.** (L. +)	4	20
3	10	do	1.411.	1.348.	0.063. (R. +)	4	30
3	20	do	1.395.	1.379.	0.016. (R. +)	4	40
3	30	do	1.348.	1.371.	0.023. (L. +)	4	50
3	40	do	1.348.	1.318.	0.030. (R. +)	5	00

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3	50	do	1.304.	1.263.	0.041. (R. +)	5	10
4	00	29. c	1.263.	1.212.	0.051. (R. +)	5	20
4	10	do	1.237.	1.290.	0.053. (L. +)	5	30
4	20	do	1.250.	1.237.	0.013. (R. +)	5	40
5	00	do	1.212.	1.263.	0.051. (L. +)	6	20

17/X. EXP. **XIV.** Periarterial Sympathectomy (distal).

No. 14 dog ♀ Deep Brown Wt. 5.000 Kgm.

(2 cms. denudat. on the **left** side at A.M. 10. 30.)

Before Periart. Sympathectomy.

Hrs.	Mins.	B.H. (R.T.)	Blood-flow per min. c.c. R.	**L.**	Diff.	Past hours af. op Hrs.	Mins
A.M. 10	00		3.002.	3.125.	0.033. (L. +)		

After Periart. Sympathectomy.

P.M. 2	40	36.5. c	3.333.	3.658.	0.125. (L. +)	4	00
3	10	do	3.000.	3.243.	0.243. (L. +)	4	30
3	20	do	2.752.	3.243.	**0.491.** (L. +)	4	40
3	30	do	2.830.	2.970.	0.140. (L. +)	4	50
3	40	do	2.727.	2.926.	0.199. (L. +)	5	00
3	50	do	2.752.	2.941.	0.198. (L. +)	5	10
4	00	do	2.325.	2.307.	0.018. (R. +)	5	20
4	10	do	2.264.	2.238.	0.026. (R. +)	5	30
4	20	do	2.380.	2.238.	0.142. (R. +)	5	40
4	30	do	2.264.	2.264.	0.	5	50
5	00	do	2.500.	2.309.	0.191. (R. +)	6	20

In Experiment XIII, the greatest difference between the two sides was 0.094 c.c. at 4 hours and 20 minutes; the increase in blood-flow on the operated side was smaller still than in the case of the previous experiment; whereas in Experiment XIV, where the denudation was of a length of 2 c m.s, the greatest differences were 0.210 c.c.s at 4 hours and 30 minutes, and 0.458 c.c.s at 4 hours and 40 minutes; the increase in blood-flow was thus far greater than when the denudation was of a length of only 1 c.m., but it was still within the limit of the physiological difference.

Reinhold Ahrens has recently published the view that Leriche's treatment is disadvantageous in various respects, quoting several clinical instances in which he claims to have obtained the same result as periarterial sympathectomy by obtusely detaching the art. femoralis from the surrounding parts at a distance of 1 c.m.. In order experimentally to ascertain whether this view was well founded or not, I merely detached entirely from its periphery the arteria femoralis from immediately below the lig. Pouparti to the fork formed by the vena femoralis and vena saphena magna, and examined the difference in blood-flow consequent thereon, with the following results.

20/X. EXP. **XV.** An instance of the **left** art. femoralis merely being freed from the surrounding parts.
No. 15 dog ♂ White Wt. 3.600 Kgm.
(Operation : P.M.O. 05.)

Before Operation.

Hrs.	Mins.	B.H. (R.T.	Blood-flow per min. c.c. R.	L.	Diff.	Past hours af. op. Hrs.	Mins.
A.M. 12	00	34.5. c (19.5)	2.857.	3.243.	0.386. (L. +)		
			After Operation.				
P.M. 4	35	do	3.333.	3.846.	**0.513.** (L. +)	4	30
5	05	do	2.343.	2.608.	0.255. (L. +)	5	00
5	15	do	2.272.	2.666.	0.394. (L. +)	5	10
5	35	do	1.986.	2.142.	0.156. (L. +)	5	30
5	45	do	2.142.	2.363.	0.221. (L. +)	5	40
6	05	35. c (18.5)	1.904.	2.285.	0.381. (L. +)	6	00
6	25	do	0.956.	0.937.	0.019. (R. +)	6	20
6	35	do	0.888.	0.923.	0.035. (L. +)	6	30
6	45	do	0.833.	0.905.	0.072. (L. +)	6	40
7	05	32. c (do)	0.727.	0.754.	0.027. (L. +)	7	00
7	15	do	0.705.	0.750.	0.045. (L. +)	7	10

6/XI. EXP. **XVI.** An instance of the **left** art. femoralis merely being freed from the surrounding parts.
No. 16 dog ♂ Brown Wt. 5.300 Kgm.
(Operation : A.M. 11. 50.)

Before Operation.

Hrs.	Mins.	B.H. (R.T.)	Blood-flow per min. c.c. R.	L.	Diff.	Past hours af. op. Hrs.	Mins.
A.M. 11	30		1.894.	1.855.	0.039. (R. +)		
			After Operation.				
P.M. 4	20	37. c (22)	2.142.	2.000.	0.142. (R. +)	4	30
4	30		1.655.	1.666.	0.011. (L. +)	4	40
4	40		2.666.	2.857.	0.191. (L. +)	4	50
4	50	do.	1.714.	2.260.	0.546. (L. +)	5	00
5	00		1.714.	2.220.	0.508. (L. +)	5	10
5	10		1.777.	2.000.	0.223. (L. +)	5	20
5	20		1.714.	2.068.	0.344. (L. +)	5	30
5	40		2.000.	2.666.	0.666. (L. +)	5	50
6	10	37. c (18)	1.791.	2.400.	0.609. (L. +)	6	20
6	20		1.846.	2.400.	0.554. (L. +)	6	30
7	00		2.000.	2.666.	0.666. (L. +)	7	10
7	20	36.5. c (17)	1.621.	2.352.	**0.731.** (L. +)	7	30
Next morning.							
A.M. 8	50	36.5. c (11.5)	1.714.	2.105.	0.391. (L. +)	21	10
9	15		1.920.	2.000.	0.080. (L. +)	21	35
9	35	do (13)	2.142.	2.181.	0.040. (L. +)	21	55

7/XI. EXP. **XVII.** An instance of the **left** art. femoralis merely being freed from the surrounding parts.
No. 17 dog ♂ Reddish brown Wt. 6.250 Kgm.
(Operation : A.M. 11. 30.)

Before Operation.

Hrs.	Mins.	B.H. (R.T.)	Blood-flow per min. c.c. R.	L.	Dsff.	Past hours. af op. Hrs.	Mins.
A.M. 10	20		3.000.	3.243.	0.243. (L. +)	Balance 0.056. (R.)	
10	25		3.157.	2.857.	0.300. (R. +)		
			After Operation.				
P.M. 4	00		2.857.	2.790.	0.087. (R. +)	4	30
4	10		2.926.	2.891.	0.035. (R. +)	4	40
4	20		2.666.	2.790.	0.124. (L. +)	4	50
4	30		2.608.	2.857.	0.249. (L. +)	5	00
4	40		2.608.	2.825.	0.217. (L. +)	5	10
4	50		2.400.	2.666.	0.266. (L. +)	5	20
5	00		2.448.	2.727.	0.279. (L. +)	5	30
6	00		2.222.	2.448.	0.226. (L. +)	6	30
6	40	36. c (11)	1.967.	2.285.	**0.318.** (L. +)	7	10
7	00		1.875.	2.142.	0.267. (L. +)	7	30
7	40	36. c (10.5)	1.875.	2.068.	0.193. (L. +)	8	10
Next morning.							
A.M. 8	50	37.3. c (12)	1.518.	1.648.	0.130. (L. +)	21	30
9	10		1.371.	1.445.	9.174. (L. +)	21	50
9	45	36. c (14)	1.411.	1.600.	0.189. (L. +)	22	25
9	55		1.648.	1.648.	0.	22	35
10	00		1.394.	1.411.	0.017. (L. +)	22	40
10	10		1.538.	1.454.	0.084. (R. +)	22	50
10	15		1.395.	1.333.	0.062. (R. +)	22	55

9/XI. EXP. **XVIII.** An instance of the **left** art. femoralis merely being freed from the surround parts.

No. 18 dog ♀ Brown Wt. 6.200 Kgm.

(Operation: A.M. 10. 30)

Before Operation.

Hrs.	Mins.	B.H. (R.T.)	Blood-flow per min. c.c. R.	L.	Diff.	Past hours af. op Hrs.	Mins.
A.M. 10	15	36.5. c (13)	1.578.	1.481.	0.097. (R. +)	Balance 0.073. (R. +)	
10	20	do	1.764.	1.714.	0.050. (R. +)		
			After Operation.				
P.M. 3	00		2.448.	3.000.	0.552. (L. +)	4	30
3	10		1.791.	2.307.	**0.616.** (L. +)	4	40
3	20		1.846.	2.000.	0.154. (L. +)	4	50
3	30	36. c (19.5)	1.764.	1.951.	0.187. (L. +)	5	00
3	40		2.000.	2.086.	0.086. (L. +)	5	10
3	50		1.935.	2.181.	0.246. (L. +)	5	20
4	00		1.739.	1.818.	0.079. (L. +)	5	30
4	20		1.621.	1.764.	0.143. (L. +)	5	50
4	30	36. c (19.5)	1.739.	1.846.	0.107. (L. +)	6	00
4	50		1.714.	2.000.	0.286. (L. +)	6	20
5	00		1.714.	1.967.	0.253. (L. +)	6	30
5	10		1.666.	1.777.	0.111. (L. +)	6	40
5	30		1.500.	1.666.	0.166. (L. +)	7	00
5	50		1.600.	1.920.	0.320. (L. +)	7	20
6	00	35.5. c (18)	1.564.	2.068.	0.504. (L. +)	7	30
6	20		1.454.	1.600.	0.146. (L. +)	8	00
6	30	do. (17.5)	1.500.	1.714.	0.214. (L. +)	8	10

14/XI. EXP. **XIX.** An instance of the **right** art. femoralis merely being freed from the surrounding parts. (**2** days af. op.)

No. 19 dog ♀ Black Wt. 6.000 Kgm.

Hrs. P.M.	Mins.	B.H. (R.T.)	Blood-flow per min. c.c. R.	L.	Diff.
3	30		1.655.	1.714.	0.019. (L. +)
3	40		1.655.	1.666.	0.011. (L. +)
3	50	34. c (20)	1.500.	1.538.	0.038. (L. +)
4	00		1.600.	1.714.	0.114. (L. +)
4	20		1.500.	1.411.	0.089. (R. +)

In these instances, the greatest difference between the right and left was 0.127 c.c. in favour of the operated side at 4 hours and 30 minutes after the operation in Experiment XV, while in other cases it was the opposite side that showed a longer figure. In short, the results were not uniform. In Experiment XVI the blood-flow on the operated side began to increase about 4 hours and 40 minutes after the operation until at 7 hours 30 minutes after the operation the greatest difference was 0.770 c.c. (allowing for the difference in normal conditions); but 20 hours and upwards after thd operation no difference was perceptible between the right and left sides. In Experiment XVII, blood-flow on the operated side was observed to be greater than on the other side from 4 hours and 40 minutes from the operation onwards, but the difference, even at its height, 0.374 c.c. at 7 hours and 10 minutes after the operation, was within the limit of the physiological difference, and subsequent to 22 hours and 40 minutes after the operation, blood-flow was actually greater on the other side than on the operated side. In Experiment XVIII, the greatest difference (0.689 c.c.) was observed at 4 hours and 40 minutes after the operation. At other times the difference in blood-flow between the right and left sides did not exceed the physiological difference except at 4 hours 30 minutes after the operation when the difference stood at 0.625 c.c.. In Experiment XIX no difference was perceptible between the two sides two days after the operation.

The results of the foregoing five experiments were thus either ununiform or that even though some difference in blood-flow was perceptible between the right and left, such difference vanished about 20 hours after the operation.

In short, the effect of this treatment was found to be of shorter duration and limited to fewer hours than that of periarterial sympathectmoy even if some effect was to be perceived shortly after the operation.

General Survey and Observations.

In the light of the results of my Experiments I–VI, VIII–X, XIII and XIV, it would appear that so far as dogs are concerned, Periarterial Sympathectomy effected to the length of 3 c.m s from a point 1 c.m. below the lig. Pouparti is followed by a greater increase in the blood-flow in the hind limb affected than the same operation of a greater or lesser length.

The results of the experiments were also in accord with the view advanced by Lerichc, Brüning, etc. that Periarterial Sympathectomy effected immediately above or below the lig. Pouparti or at the distal of the arteria femoralis is ineffectual.

As regards the length of denudation that is calculated to produce the greatest effect, however, there must obviously be a difference between the dog and man due to the anatomical differences existing between the two both in the length of legs and in the vascular system, so that from 8 to 10 c m.s for the human body may be what corresponds to 3 c.m.s for the dog.

But this is a point the elucidation of which must be reserved for further investigations. Further, the view of Leriche that the longer denudation is the greater is the effect does not agree with the results of my experiments, for in Experiment VII denudation was made to the length of 3 c.m.s on the right side and 7 c.m.s on the left side, that is to say, the denudation on the left side was 4 c.m.s longer than on the right side, and yet the increase in blood-flow was always found to be greater, though to a slight extent, on the side on which the longer denudation of the two was effected. A comparision of Experiment VIII with Experiment IX and X will also show that the greatest difference between the right and left three days after the operation was greater in the case of Experiment

VIII, where the denudation was of a length of 3 c.m.s, than in the case of the two other experiments, where a longer denudation was effected.

How is this phenomenon to be accounted for?

Periarterial Sympathectomy is premised on the hypothesis that the main fiberes of the sympathetic nerve exist in the periarterial wall, and the operation is in intended to cause the dilatation of the blood-vessels in the distal by putting an end to the control of the vasoconstrictors.

Since Jaboulay attempted to ascertain the real nature of this operation, many investigators have taken the matter up and innumerable views have been published on this subject.

Among some other latest views, mention may be made of that of Bayliss who having made his investigations on dogs by means of plethysmograph, explained in 1900 that the vasodilator fibres, instead of passing through the abdominal sympathetic chain, went down along with the mixed nerve to the segmental in the art. femoralis. Since then, Wiedhopf (who as a result of his experiments on dogs in which he made use of plethysmograph came to the conclusion that the efferent sympathetic nerves to the hind limbs ran with the sciatic and entered segmental in art. femoralis), Langley (who experimented on cats subject to various stimulations and reached the conclusion that the vasoconstrictors did not run with the arteries to the periphery but descended together with the mixed nerve), Schilf (who used dogs in his experiments and arrived at the conclusion that in the periarterial wall of the art. femoralis there were no efferent nerve fibres supplying), Dennig (who experimented on dogs and came to the conclusion that in the periarterial wall of the art. femoralis in the thigh there were no sensory nerves to the leg), Friedrich (who in collaboration with Böwing experimented by means of plethysmograph and found that the long vegetative nervous course did not go to the periphery along the vessels, but descended with the mixed nerves and entered the vessels segmental) and Dumpert and Flick (who experimented on dogs in which they found no longer sensory periarterial running course) all these have affirmed that the sympathetic nerve fibres come to the hind limb with mixed nerves

and enter segmental in the vessel wall. More especially, Dumpert and Flick cut off part of art. femoralis on which periarterial sympathectomy had been effected and then sewed it up in its old place and injected various stimultants into the arteria in order to observe that which they claim to be in support of their view. At the same time Braencker, Hahn and Franzhunczek as well as Pott have, as a result of their anatomical investigations, published the view that vascular nerves enter segmental.

On the other hand Brüning surmises that apart from the vasomotric course where they enter segmental in the vessel wall, there is what is called "vasosensible sympathische Bahn", which without any connection with the spinal nerves, emerges directly from the sympathetic trunk and goes to the periphery along the vessel. Hahn also remarks that there are two kinds of efferent nerve fibres in vessels, namely, those which enter segmental in vessels and a long centripetal course existing as periarterial plexus.

All the results of experiments made by such noted investigators as quoted above, however, are not calculated to solve the puzzle of why in the case of dogs denudation longer than 3 c.m.s is followed by a very slight increase in bloow-flow. So this is evidently a question that requires further and more minute investigations to solve.

For the present I have to content myself with merely pushing the fact that such was the result of experiments made by myself.

To sum up:

(I) Periarterial Sympathectomy on the arteria femoralis of dogs would appear to be followed by the most pronounced increase in the blood-flow in the hind limb when denudation is of a length of 3 c.m.s from a point 1 c.m. immediately below the lig. Pouparti, while long denudations result in a smaller increase in blood-flow.

(II) Denudation in the arteria iliaca externa (close on lig. Poupart), in the topmost part of the arteria femoralis (immediately below lig. Pouparti), or at the distal, is followed by a smaller increase in the blood-flow in the hind

limb than in the case of denudation of a length of 3 c.m.s (beginning at 1 c.m. immediately below the lig. Pouparti).

(III) The effect of a mere detachment of arteria femoralis from the periphery upon the blood-flow in the hind limb is of a by far shorter duration than that of periarterial sympathectomy.

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